РАЗДЕЛ 6.
ХРАНЕНИЕ И ПЕРЕРАБОТКА

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THE DEPENDENCE OF TUBERS QUALITY UPON THE CULTIVARS OF POTATO WITH FLESH COLOUR

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Recently pigmented tuber flesh in potato attracts much attention of scientists and consumers due to their bioactive substances as well as an unusual and attractive appearance and taste. Therefore, the products made from potato tubers with blue flesh can be a great alternative to traditional foods.

'Blue Congo' and 'Vitelotte' potato cultivars with blue tuber flesh were investigated. By applying standard methods potato tuber chemical composition was investigated, boiled tuber culinary properties were evaluated. Research results showed that 'Vitelotte' potato tubers are substantially richer in amount of anthocyanins, dry matter, crude ash and potassium, and there is less nitrates accumulated than in 'Blue Congo' tubers. Boiled 'Blue Congo' tubers were moderately soft, of a rough structure, bright flavour, mealier and drier, while the 'Vitelotte' are of the average hardness, of the softer structure, with sufficiently brighter flavour, slightly mealier and more humid.

Keywords: Blue-flesh potatoes, boiling, sensory evaluation

INTRODUCTION

The potato (*Solanum tuberosum* L.) is one of the most important vegetable and a part of daily food utilization of almost all the world population. It is a balanced food containing high energy, nutritional quality protein, essential vitamins and minerals [1].

Mostly, the skins and/or fleshes of the stem tubers of the generally cultivated varieties of potato are white, yellow or lemon yellow. Worldwide, the potato cultivars in which the skins and/or fleshes of the stem tubers are blue, red, purple or orange are intuitively denominated coloured potatoes [2].

As indicated by various studies, colored potatoes provide a natural source of phytochemicals such as anthocyanins, phenolic compounds, flavonoids [3]. Anthocyanins content in blue fleshed potatoes is two to three times higher than in white-fleshed potatoes [4]. The role of potato polyphenols as antioxidants, anti-carcinogenic and anti-mutagenic agents have been reported in numerous

studies. Potato polyphenols are effective against human liver, colon, and prostate cancer cells [5].

The presence of these metabolites suggests that purple-fleshed potatoes can be natural colorants or antioxidant sources for the food industry. Potatoes can be prepared in many ways, including baking, boiling, roasting, frying, and microwaving, allowing for a diversity of uses [6].

Boiling is a very popular method of cooking for potatoes [7]. Boiling reduced or, in some cases, retained, or enhanced the total phenolic and nutrition's contents of potato genotypes with respect to uncooked samples. Researchers found that boiling for 20 minutes did not alter the phenolic acid content but decreased the anthocyanin content of colored-flesh cultivars [8].

Using sensory evaluation, information about the human perception of potato quality is obtained, as the senses of sight, smell, taste, touch and hearing are studied. In sensory analysis, the texture is evaluated in terms of moistness, adhesiveness, mealiness, etc [9].

MATERIALS AND METHODS

Two species of potato with blue tuber flesh were tested: 'Blue Congo' and 'Vitelotte'. Laboratory sample comprised 5 kg. Some tubers were used for chemical analyses, the rest were used for sensory analysis of boiled potatoes. In Aleksandras Stulginskis University, in plant–raw material quality testing laboratory by applying standardized methods potato tuber chemical composition has been established:

- dry matter content - by draying samples at temperature of 105 ^{o}C to the
- constant weight [10];
- vitamin C –Murri's titrimetric method [11];
- level of potassium– A-L method by ion metre with potassium selective electrode;
- nitrates - ion metric method [12];
- amount of crude protein – by the Kjeldahl method [13];
- amount of crude ash - combustion 550 °C;
- amount of crude fiber – by the method of Heneberg – Shtoman [14].

Total anthocyanin content was measured using a spectrometric method. The pigment content in blue coloured potatoes was calculated as Cyanidin 3,5-diglucoside [15]. Level of anthocyanin was established in the Immanuel Kant Baltic Federal University (Kaliningrad).

Boiled tuber culinary properties such as falling to pieces, consistency, mealy, dryness, texture, taste, were evaluated sensorically applying 4 point evaluation system [16].

Colour of raw and boiled potato tubers was evaluated by COLORFLEX spectrophotometer using the CIE system [17], where L* value describes the brightness (black, when L*=0 and white when L*=100), a* describes the intensity of the red colour (a*>0) or green (a*<0), b* describes the intensity of

the yellow colour (b*>0) or blue (b*<0). L*, a* and b* values are measured in NBS units.

The data were presented as mean±SD. One-way analysis of variance (ANOVA) was carried out using a statistical program (STATISTICA software) for $p<0.05$ significance level.

RESULTS

The amount of dry matter of potato tubers is one of the main indicators of quality of chemical composition in determining the processing of the product quality and yield. After the research it was found that substantially more, namely 6.1% of dry matter, was accumulated in 'Vitelotte' than in 'Blue Congo' potato tubers (Table 1).

The amount of crude ash in plants and distinct organs vary widely and depend on the biological properties of plant, stage of development and nutrition. The research performed by us indicates that the crude ash was 1.1 times more substantially in 'Vitelotte' than in 'Blue Congo' potato tubers (Table 1).

Crude protein and crude fibre content in both genotypes of potato tubers were similar, significant differences have not been found (Table 1).

Table 1 – Content of dry matter, crude fiber, crude protein and crude ash in tubers of potatoes 'Vitelotte' and 'Blue Congo' cv.

Cultivar	Dry matter, %	Content of, % d.m		
		Crude fiber	Crude protein	Crude ash
'Vitelotte'	23.7 ± 0.37^{a}	2.94 ± 0.14^{a}	7.37 ± 0.13^{a}	5.31 ± 0.13^{a}
'Blue Congo'	17.6 ± 0.49^{b}	2.80 ± 0.11^{a}	7.81 ± 0.09^{a}	4.73 ± 0.04^{b}

*- means located on the same column and marked with different letters reliably, when $p<0,05$.

The amount of potassium in potatoes can vary considerably as it depends on growing conditions and cultural practices applied. Results of our research showed that potassium was accumulated substantially higher, namely 4.7% in 'Vitelotte' potato tubers than 'Blue Congo' (Table 2).

The amount of vitamin C of potato tubers of both genotypes was similar, significant differences were not identified, and it was equal to 4.69 mg 100 g^{-1} 'Blue Congo' and 7.04 mg 100 g^{-1} 'Vitelotte' tubers (Table 2).

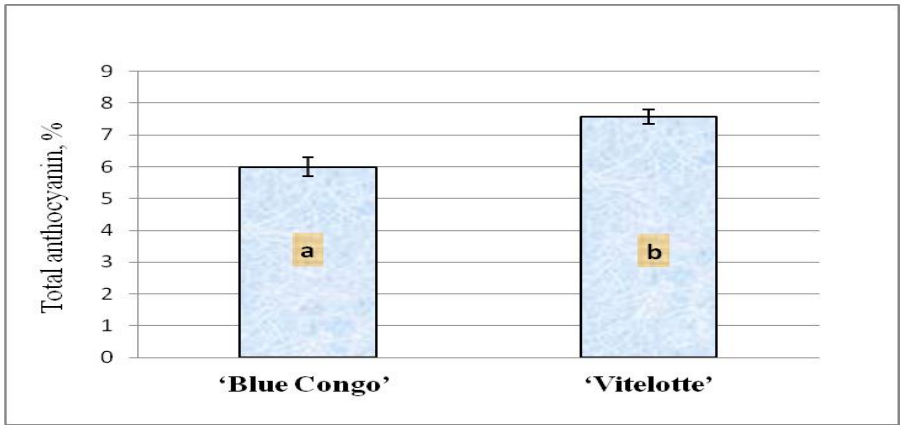
The amount of nitrates in tubers depends on the characteristics of species, meteorological conditions during the growing season, fertilizing, potato maturity and size of the harvest. It was found that 'Blue Congo' potato tubers accumulated 3.5 times substantially higher levels of nitrates than 'Vitelotte' (Table 2).

Table 2 – Content of vitamin C, potassium and nitrates in tubers of potatoes ‘Vitelotte’ and ‘Blue Congo’ cv.

Cultivar	Vitamin C, mg 100 g^{-1}	Potassium, mg 100 g^{-1}	Nitrates, mg 100 g^{-1}
‘Vitelotte’	7.04 ± 1.52^{a}	28.2 ± 2.16^{a}	6.82 ± 0.94^{b}
‘Blue Congo’	4.69 ± 0.51^{a}	23.5 ± 0.32^{b}	23.9 ± 2.05^{a}

*- means located on the same column and marked with different letters reliably, when p<0,05.

Anthocyanin’s are a group of red-blue plant pigments. These pigments are characterized by a large pharmacological activity [18]. Our research showed that total anthocyanin content essentially 1.3 times higher was in ‘Vitelotte’ potato tubers than in ‘Blue Congo’ (Figure 1).



*– means market with different letters differ reliably when p<0,05

Figure 1 – Total anthocyanin content in tubers of potatoes Vitelotte’ and ‘Blue Congo’ cv.

Boiled potato tubers were evaluated by applying organoleptic methods. Potato texture varies in different tissues and locations of the tuber. It depends on the chemical composition, structure, cell size and cell wall composition [19]. According to evaluation of tasters, texture of boiled ‘Blue Congo’ tuber was medium soft while boiled ‘Vitelotte’ tuber was medium hard (Figure 2). Having evaluated the average evaluations of potato mealy and dryness it was found that boiled ‘Blue Congo’ tubers were mealier and drier, and the ‘Vitelotte’ tubers were slightly mealy and more humid (Figure 2).

Flavor and aroma of potatoes depend on the amount of relative materials and the quantitative relation between them which changes during the processing time. Taste of boiled potatoes is influenced by nitrogen, minerals and phenolic compounds in potato tubers [20]. In regard to tasters assessments taste of boiled ‘Vitelotte’ potatoes was clear enough, but taste of ‘Blue Congo’ was strong. Having evaluation of the average assessment of the potato structure it was found

that structure of boiled ‘Blue Congo’ tuber was rougher, while cooked ‘Vitelotte’ tuber was softer (Figure 2).

Characteristics of species, amount of pectic substances, composition changes of starch grains influence the potato tuber falling into pieces [19]. The potato tuber purpose depends on their falling into pieces (salads, mashed potatoes, etc.). Having taken into account the average potato falling into pieces, it was found that ‘Blue Congo’ and ‘Vitelotte’ potato tubers do not fall into pieces (Figure 2).

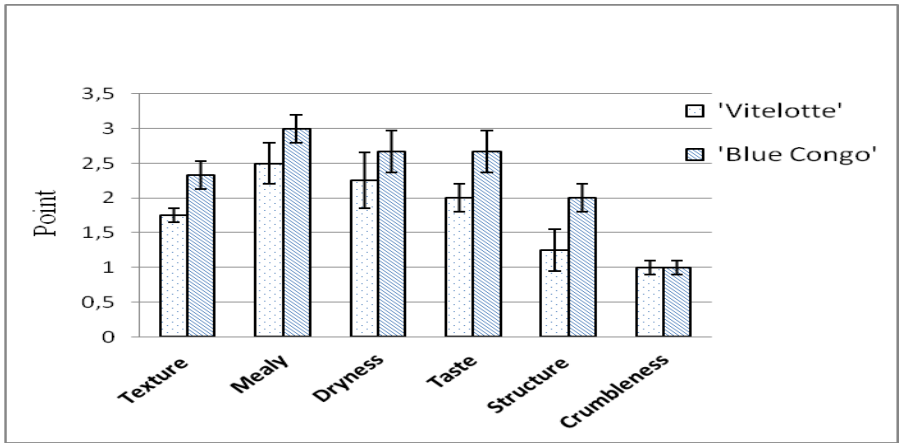


Figure 2 – The average values of potato tuber organoleptic evaluation

Furthermore, characteristics, describing the raw materials and the marketable appearance of product, of potato tuber colour, were investigated. Raw and boiled tuber luminosity L*, chromaticity coordinates a* (redness), and b * (blue) were compared (Table 3).

Colour of raw materials and the product depends on the colouring materials in it. Potato tuber with a blue colour of the flesh was influenced by the amount of natural pigments (anthocyanins). Luminosity L* of raw materials as well as the product depends on the concentration of colour pigments in them. The results of our research showed that the values of higher luminosity coordinates L* were in boiled than in raw potato tubers. Raw and boiled tubers of ‘Blue Congo’ species were lighter and reached respectively 31.06 NBS and 31.23 NBS. 2.4 and 1.2 times lower values of the coordinates were found in raw and boiled ‘Vitelotte’ tubers.

Values of chromaticity coordinates a* of both the not boiled and boiled potatoes were compared. The result of our research showed that these values are in the red scale. Increased shade of red was determined in no heat treated ‘Blue Congo’ tubers – 15.86 NBS, while in ‘Vitelotte’ tubers it was 1.2 times lower. The same trend of red remained in boiled potato tubers as well as the raw material, i.e. these values in ‘Vitelotte’ and ‘Blue Congo’ were respectively 8.90 NBS and 12.90 NBS.

The evaluation of values of colouring coordinates b* of raw materials and boiled potato tubers showed that the shade of blue was dominant. Most notable

shade of blue was indicated in ‘Blue Congo’ cooked tubers – - 18.12 NBS while in “Vitelotte” it was 1.3 times lower. In raw potato tubers, this shade was less in ‘Blue Congo’ than in ‘Vitelotte’, respectively – 7.59 NBS and -10.45 NBS.

Table 3 – Colour indicators of raw and boiled potato tubers.

Cultivar	Tubers	L*, NBS	a*, NBS	b*, NBS
‘Vitelotte’	raw tubers	12.71±0.13	13.97±0.01	-10.45±0.06
	boiled tubers	26.15±0.12	8.90±0.74	-14.09±0.69
‘Blue Congo’	raw tubers	31.06±1.12	15.86±0.70	-7.59±0.33
	boiled tubers	31.23±0.13	12.90±0.03	-18.12±0.06

CONCLUSIONS

1. The amounts of dry matter, potassium, crude ash, and anthocyanins were substantially higher in ‘Vitelotte’ potato tubers while the substantially lower nitrates were estimated in the tubers of this species.

2. Boiled “Blue Congo” tubers were moderately soft of a rough structure, expressed taste, mealier and drier, while ‘Vitelotte’ tubers were of the average hardness, the softer structure with sufficiently bright flavour, slightly mealy and more humid.

3. In boiled potato tubers more intense values of brightness coordinates L* and b* chromaticity coordinates (blue) were determined. Values of colouring coordinates a* (redness) were more intense in raw potato tubers.

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